THE MARYLAND AGRICULTURAL EXPERIMENT STATION

Bulletin No. 192. January, 1916

INTERNAL ACTION OF CHEMICALS ON RESISTANCE OF TOMATOES TO LEAF DISEASES.

J. B. S. Norton.

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Some serious study has, however, been given to working out an "inner therapy" for plants.

Soil Applications.

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1 See Sorauer. Pflanzenkrankheiten. 3rd edition. 2:143. 1908. See Rostrup. Tidsskr. for Landoekonomie. 1890, for effect of fertilizers on attack of clover by dodder.
2 Ann. de l' Inst. Pasteur, vol. 13, 1899.
3 l. c. 14: 304. 1902.
4 Zeitschr. f. Pflanzenkr. 12:343.

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Pichi[1] found benefit against grape mildew from applying copper sulfate in the soil about the attacked vines.

Marchal[2] was able to produce in lettuce plants a distinct resistance against mildew (*Bremia lactucae Regel*) by copper sulfate 3 to 4 parts per 10,000 of the nutrient solution in which the plants were grown. Five to seven parts per 10,000 was found to be injurious to the lettuce; while concentrations below 3 per 10,000 were without effect. Iron sulfate had no immunizing effect. Manganese sulfate and potash salts were also without certain result. Nitrates and phosphates favored infection.

Laurent[3] obtained negative results in trying to immunize potatoes by treatment with copper sulfate.

Direct Injection Methods.

The method of direct injection has been revived in recent years and a number of attempts made to adapt it to the requirements of plant anatomy and physiology. Mokrschetzki and Chewyreuv in Russia,[4] and Bolley in America,[5] have made use of both nutrients and poisons to control disease by injection into trees. From 1908 to 1912, the writer carried on a series of investigations on the effect of substances applied to plants internally, which are to be reported on more fully in a separate publication. Since 1912, Rumbold has been making an extended investigation of tree injections in connection with the chestnut bark disease.[6]

Serums and Toxins.

Another method with theoretical possibilities, but not of much promise practically is the use of serums or viruses made from the products of parasitic fungi in cultures or from the tissues of their parasitized hosts. Beauverie[7] immunized begonias to *Botrytis cinerea* Pers. by planting them in earth long covered with Botrytis.

Potter[8] used a toxin from *Pseudomonas destruans* to stop the growth of this organism on turnips.

Ferraris has a resumé of previous work on internal therapy of plants in Antologia Agraria, 1907, where a more complete bibliography of publications up to that time may be found.

1 Nuov. Giorn. Bot. Ital. 23: 361. 1891.
2 Compt. Rend. 135 : 1067. 1902.
3 Compt. Rend. 135 : 1040. 1902.
4 Zeitschr. Pflanzenkr. 13 : 257. 1903; St. Petersburg Imperial Soc. of Naturalists 1894, and various Russian publications.
5 N. Dak. Exp. Station, Ann. Rept. 13 : 61. 1903; 14 : 55. 1904.
6 Phytopathology 5 : 225. 1915.
7 Compt. Rend. 133 : 107. 1901; see also, Ray, l. c. 307.
8 Journ. Agri. Science 3 : 102. 1908.

Effect of Fertilizers on Corn Diseases.

Some interesting observations on the variation in corn diseases under different fertilizer treatments, not before published, were made at this Experiment Station in 1912 and 1913. It was noticed in a series of plots grown for several years on excess of various fertilizer combinations that in 1912, there was more smut on sweet corn in one plot than the others and a count of all was made with reference to the number of stalks showing smut [*Ustilago zeae* (Beck.) Ung.] and rust (*Puccinia sorghi* Schw.). Next year, the count for smut was repeated and also the relative amount of rot in the ears after picking in the fall was determined. The following table gives the results.

TABLE I

Fertilizers and Rate Per Acre Annually	1912			1913		
	No. Stalks	No. Stalks with Smut	No. Stalks with Rust	No. Stalks	No. Stalks with Smut	Per cent. Grain Rotted
Dried blood, 1,000 pounds Sulphate potash, 250 pounds Dissolved S. C. rock, 1,000 pounds	104	0	0	113	7	11.0
Dried blood, 1,000 pounds Dissolved S. C. rock, 1,000 pounds	128	6	5	119	7	12.8
Dried blood, 1 000 pounds Sulphate potash, 250 pounds	113	0	5	126	3	13.0
Dissolved S. C. rock, 1,000 pounds Sulphate potash, 250 pounds	156	22	2	118	0	11.6
Nothing	177	8	2	126	7	21.7

The most striking thing to be seen in the above is that the potash-phosphorus plot which was so badly smutted in 1912, was just as notably free from smut in 1913. The plants on the plots with heavy application of phosphate develop faster and are in bloom before the others. The difference in infection might be due to being in a susceptible stage of development at a time when smut conidia were abundant.[1]

Internal Medication of Tomatoes.

Massee[2] reports in 1903, an attempt to immunize tomatoes against *Cladosporium fulvum* Cke. Plants were watered every third day with 1-7,000 copper sulfate solution. Others not so treated were placed among them. After one month, all the treated plants were

1 See Kans. Exp. Station Bul. 62 : 186-187. 1896.
2 Journ. Roy. Hort. Soc. 28 : 142.

free from Cladosporium and some of the check plants had the disease. At this time, all the plants were sprayed with spores of the fungus and the check plants soon became badly diseased. After six weeks, the strength was increased to 1-6,000 and applied every fourth day for eleven weeks. None of the treated plants showed a trace of the disease. A chemical test failed to show the presence of copper in the plants.

Reed[1] found no variation in the amount of Phytophthora blight on tomatoes grown on various fertilizers at Blacksburg, Va., in 1910. No other disease was present that year on the experimental area.

McCue[2] reports very little leaf blight on a tomato plot which received 250 pounds of acid phosphate per acre, while plots receiving nitrogen and potash fertilizers were badly defoliated. The check plots were not badly injured, but were worse than the phosphate plot.

Work on Tomatoes at this Experiment Station.

In the spring of 1907, an experiment was started here by C. P. Close and W. R. Ballard for the purpose of determining whether or not the application of a solution of copper sulfate to the soil of pots in which tomato plants were growing would make the plants more resistant to disease. The following results are reported from Mr. Ballard's notes: "Six plots with ten plants in each plot were treated with the solution. An additional plot was used as a check. The plants were kept in pots and the solution was applied once or twice a week, beginning with 2 cc. per pot and gradually increasing the quantity until the plants had been transplanted to eight-inch pots when 50 cc. was applied to each pot. Varying strengths were used and in the three months that the test was run, the total amount of copper sulfate applied to each pot varied from .0342 grams to 1.75 grams.

The plants were apparently not injured and no doubt a larger quantity could have been applied with no ill effects. No attempt was made to determine how much of the copper sulfate was taken up by the plants, nor what chemical reactions may have taken place in the soil.

An attempt was made to inoculate one plant of each plot with the bacterial wilt, but without success, even on the check plot. One plant in each plot was then sprinkled with an infusion from the leaves of tomato plants badly affected with Septoria. Some of the affected leaves were also placed beneath the plants. The disease

1 Va. Exp. Sta. Bul. 192. 1911.
2 Del. Exp. Sta. Bul. 101 : 18. 1913.

soon attacked the plants and spread rapidly to all the plants in the several plots. There seemed to be no difference in the susceptibility of the plants in any of the plots."

In 1912 and 1913, the writer, with the assistance of Mr. Wm. H. White carried on a series of tests of a large number of different chemicals as to their effect on infection of tomatoes by *Septoria lycopersici* Speg. and *Cladosporium fulvum* Cke. The chemicals were applied in solutions of different proportion in distilled water placed in glass tumblers into which the roots of the young plants extended from paraffined paper pots in which they were transplanted, as shown in Fig. 1. Those used in 1912, were in washed glass sand and in 1913, in rich loam.

FIG 1.

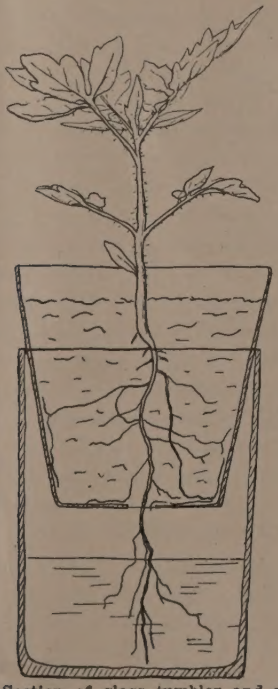

FIGURE 1. Section of glass tumbler and pot showing method of applying chemicals to tomato roots.

In general, four different concentrations, with a distilled water control were used in duplicate for each chemical. One set of each was inoculated with Cladosporium and the other with Septoria obtained

by washing recently diseased leaves in water, into which the plants in the experiment were then dipped.

The device used allowed the solutions studied to come in contact with the roots without being acted upon by the soil, except through the plants. The most uniform results were obtained when a single root came through the hole in the bottom of the pot. If there were more, they often acted as a wick and took up the solution so rapidly as to keep the soil in the pot too wet for favorable growth. A single root would usually take up the solution quite readily. No analyses were made to see whether the substances in solution actually entered the plant, or what selective action the roots had. In most of the tests, the "Green Stem" cherry variety described in Proc. Soc. Hort. Science, 1910:71, was used. The plants were 4 to 6 inches high and had about 6 leaves. The roots were cut off to a uniform length, so that the end just reached the bottom of the tumblers. The plants were kept on greenhouse benches, with the usual greenhouse conditions of temperature and humidity. The glasses had about 200 cc. capacity and about 60 to 100 cc. of solution was used in each.

The Septoria and Cladosporium were selected on account of their abundance and the ease with which plants can be infected with them. Some preliminary tests of infecting tomatoes with *Septoria lycopersici* were made, and it found that the cycle from spore to spore could be completed after inoculation in from 5 to 10 days, depending chiefly upon the temperature; infections being obtained with ease and in abundance under a variety of conditions. However, in the tests with chemicals, we failed to secure infections in a number of cases, even on the checks in distilled water, though every favorable condition that was thought of was given. For this reason, the results with many of the chemicals tried are inconclusive.

As the experiments progressed, there was so little indication of value in reference to increased resistance due to the chemicals used that the work was not carried to completion. It is possible that more careful repetitions might show more decided conclusions. In addition to the disease resistance effects, the results as shown in the following pages are of some value in showing the concentrations of different substances at which injury to tomatoes resulted. This, of course, is much higher than the concentrations necessary to reduce growth.

Summary of Chemicals Used and Results From the Same.

1. *Chemicals showing possible effect on leaf disease development.* In the following trials, there is shown a variable amount of Sep-

toria or Cladosporium which, in most cases, seems to bear some relation to the concentration acting on the plants. The dates are those on which the cultures were started.

Barium Nitrate. August 12, 1913. Concentrations used: 1-100, 1-200, 1-500, 1-1,000. Slight injury showed after 7 days on the 1-100. In 13 days, Septoria spots were found on all, including the water check plant; 3 spots on the 1-100, 6 spots on the 1-200, 8 spots on the 1-500 and 6 spots on the 1-1,000 cultures.

Calcium Chloride. July 17, 1913. Concentrations used: 1-1,000, 1-1,500, 1-2,000, 1-2,500. None of the plants showed injury, but after 12 days Septoria had developed as follows: None on the 1-1,000, 15 spots on the 1-1,500, 19 spots on the 1-2,000, 19 spots on the 1-2,500, and only 4 spots on the water culture. This substance was used also August 23, 1912 and showed injury after 2 days on concentrations down to 1-1,000, the weakest then used.

Calcium Nitrate. September 12, 1913. Concentrations used: 1-100, 1-200, 1-250, 1-300. After 8 days, the 1-100 plants were dead. A few Septoria spots were found on the 1-200 culture, and the same abundant on the weaker cultures, including the check in water. Calcium nitrate was used July 26, 1913, in the following strengths: 1-50, 1-75, 1-100, 1-150 and showed injury on all in from 2 to 6 days, according to the strength.

Cerium Sulfate. July 18, 1812. Concentrations used: 1-500, 1-1,000, 1-5,000, 1-10,000. Injury showed in 6 days on the two stronger concentrations. Cladosporium developed only on the 1-5,000 cultures. Septoria showed in 2 days on the 2 stronger and later injured cultures also on the check and in 5 days on the other two. These are probably from accidental infections taking place before the test culture was started. Cerium sulfate was also used June 30, 1913, in 1-250, 1-500, 1-750 and 1-1,000 concentrations. In 1 to 2 days the plants in these turned yellow; no leaf fungi developing.

Copper Sulfate. April 13, 1912. Concentrations used: 1-100, 1-1,000, 1-10,000, 1-100,000, 1-1,000,000. Injury showed as dark spots in 2 days on the 1-100. The other plants had turned yellowish in 11 days, but all had developed Septoria, those in the 1-10,000 and 1-100,000 showing more spots than the others.

April 20, 1912. Concentrations used: 1-500, 1-1,000, 1-5,000 1-10,000, 1-50,000 and 1-100,000. In 2 days, the 1-500 plants had turned brown, as also the lower leaves on the 1-1,000 and 1-5,000 cultures. These 3 were all dead in 6 days. After 14 days, 7 Septoria spots had developed on the plant in water; 13 on the 1-50,000 plant; 17 on the 100,000 and 12 on the 1-10,000.

April 27, 1912. Concentrations used: 1-6,000, 1-7,000, 1-8,000,

1-9,000, 1-10,000 and 1-12,000. On May 4, all the plants, except the check in water showed injury. In 6 days, most of the plants were dead and both Septoria and Cladosporium had developed on the remaining ones infected with the same.

June 24, 1912. Concentrations used: 1-500, 1-1,000, 1-5,000, 1-10,000. Injury showed as black spots in the higher concentrations in from 1 to 5 days. No injury developed on 1-10,000 solution, which, with the water culture, developed Cladosporium in 5 days and Septoria in 10 days.

July 28, 1913. Concentrations used: 1-2,000, 1-5,000, 1-7,000 and 1-10,000. Injury resulted on all but the latter, but no leaf fungi developed even on the check.

Dissolved South Carolina Rock Fertilizer. December 17, 1913. Concentrations used: 1-100, 1-200, 1,300 and 1-400. No injury resulted to any. In 10 days, Cladosporium had developed on all, including the check in water, and Septoria had developed only on the control plant, but showed several days later on the 1-400 concentration. This agrees with McCue's statement, that phosphate fertilizers are unfavorable to development of the leaf blight.

Lime Water. July 18, 1912. Concentrations used: 1-0, 1-1, 1-3, 1-7 and 1-15. Injury showed in 4 to 6 days on the 3 higher strengths. Septoria developed on the others in 2 days (from previous accidental infection?) and in 5 days, on the control plant.

July 8, 1913. Concentrations used: 1-7, 1-15, 1-25 and 1-50. No injury resulted on any, but the attempted infections all failed.

Mercuric Chloride. July 31, 1913. Concentrations used: 1-500, 1-1,000, 1-5,000, 1-10,000. In 5 days, the plants on the 1-500 and 1-1,000 concentrations were severely injured. After 10 days, the 1-5,000 plants showed injury, but the Septoria plant had developed a few spots. The 1-10,000 plants showed some injury and developed Septoria in abundance, as also did the water culture.

Morphine Acetate. June 18, 1912. Concentrations used: 1-500, 1-1,000, 1-10,000, 1-100,000. Injury showed in 3 days on the lower leaves of the 1-500 culture, but none on the others. Septoria developed in 6 days on the 1-100,000 and the control in water.

Oxalic Acid. May 3, 1912. Concentrations used: 1-100, 1-200, 1-300 and 1-400. The plants in the 2 stronger showed severe injury at the base in 3 days, but the tops remained green for sometime later. In 7 days, Septoria had developed on all 4 cultures and the water control and Cladosporium on all but the 1-100 and 1-200, which were dead. This was repeated on June 25, 1912, all the plants showing injury at the base in 1 to 2 days, but no infection resulted. On July 28, 1913, oxalic acid was used as follows: 1-400, 1-500, 1-600, 1-700.

Injury showed at the base in 2 to 3 days on all. No infections resulted. This was repeated September 12, 1913, with concentrations down to 1-800. All the plants were dead in 8 days, except the water control, which alone had developed Septoria.

Phloroglucin. August 10, 1912. Concentrations used: 1-200, 1-500, 1-1,000 and 1-5,000. Injury showed next day on all but the last. No infections.

July 19, 1913. Concentrations used: 1-500, 1-1,000, 1-1,500 and 1-2,000. In 2 days, the 1-500 plant was dead, the leaves being a dark brown, and the others showed brown spots at the edges. No infections developed.

September 10, 1913. Concentrations used: 1-2,000, 1-3,000, 1-4,000 and 1-5,000. After 8 days, the 1-2,000 plants were dead, 6 spots of Septoria showed on the 1-3,000, 10 on the 1-4,000 and a large number on the 1-5,000, and 9 on the water check plant. Septoria developed later in abundance on all but the first.

Potassium Nitrate. August 5, 1913. Concentrations used: 1-100, 1-500, 1-1,000 and 1-5,000. The plants on the 1-100 were killed in 3 days, the others survived. No infection appeared.

September 17, 1913. Concentrations used: 1-200, 1-300, 1-400 and 1-500. No injury developed on any. A few spots of Septoria had developed in 6 days on the 3 higher concentrations, and in abundance on the 1-500 and on the water control.

Potassium Permanganate. June 26, 1912. Concentrations used: 1-100, 1-500, 1-1,000 and 1-5,000. Injury showed in 2 days on the first and in 4 days on the second and third. The 1-5,000 developed Septoria in 4 days.

July 8, 1913. Concentrations used: 1-800, 1-1,000, 1-2,000 and 1-5,000. No injury resulted on any. After 13 days, 20 Septoria spots showed on the 1-2,000, 5 spots on the 1-5,000 and 4 spots on the water control. None on the others.

Sodium Acetate. September 17, 1913. Concentrations used: 1-100, 1-150, 1-200 and 1-250. In 5 days, all the plants were dead, except the water control on which Septoria developed in 6 days.

January 24, 1914. Concentrations used: 1-500, 1-600, 1-700, 1-800. No injury resulted. Cladsporium developed on all the plants, but more abundantly on the water control. A few spots of Septoria showed in the 1-500 and 1-700 plants only.

Sodium Nitrate. August 6, 1913. Concentrations used: 1-100, 1-500, 1-1,000, 1-5,000. In 6 days, the plants on the 1-100 strength had died. No others showed injury. A few Septoria spots appeared in 6 days on each of the other cultures, except the plant in water.

Sodium Tungstate. August 10, 1912. Concentrations used: 1-500,

1-1,000, 1-5,000 and 1-10,000. Injury showed next day on the first two. Septoria developed in 5 days on the 1-10,000 and the water cultures.

July 19, 1913. Concentrations used: 1-1,000, 1-2,000, 1-3,000 and 1-4,000. In from 2 to 5 days, injury showed on all but the latter. No infection developed except 6 spots of Septoria in 7 days on the 1-3,000 culture.

September 8, 1913. Concentrations used: 1-2,500, 1-3,000 and 1-4,000. No injury resulted. In 7 days, 10 spots of Septoria showed on the 2 plants in 1-2,500 concentration. Six spots on the 1-3,000, 10 spots on the 1-4,000 and 8 spots on the control in water. In a few days, all were covered with Septoria spots.

2. *Chemicals used without evident effect on leaf parasites.*

With the following cultures with various chemicals, either no infections were secured even on the control plants in water, or the leaf diseases appeared equally on all plants not killed by the chemicals, or infections were so infrequent as to be without value.

Acetone. July 3, 1912. 1-100, 1-500, 1-1,000, 1-10,000. No injury.

Ammonia. August 13, 1913. 1-50, 1-100, 1-200, 1-500. No injury.

Asparagin. August 12, 1912. 1-100, 1-500, 1-1,000. The first showed injury in 2 days.

July 21, 1913. 1-50, 1-75, 1-100, 1-200. Plants wilted in 2 to 3 days in all except the latter and in the water check.

Barium Chloride. August 12, 1912. 1-500, 1-1,000, 1-10,000, 1-100,000. Injury to the first two in 1½ days.

July 26, 1913. 1-1,000, 1-1,500, 1-2,000, 1-5,000. No injury.

September 10, 1913. 1-500, 1-1,000, 1-1,500, 1-2,000. No injury to any. Septoria developed equally on all, or a little less at first on the stronger concentrations.

Barium Oxide. August 23, 1912. 1-100, 1-500, 1-1,000, 1-10,000. Injury on the first in 1 day.

July 17, 1913. 1-100, 1-150, 1-200, 1-400. In 4 days, plants on first dead, one dead and one turning yellow on the 1-150, the others showed no injury.

September 5, 1913. 1-150, 1-200, 1-300, 1-400. Plants on the 1-150 dead in 3 days, no injury on the others. Septoria developed equally on all that lived.

Carbolic Acid. July 18, 1912. 1-100, 1-500, 1-1,000, 1-10,000. The plants on 1-100 had the stem turned black in one-half day, the 1-500 the same in 1 day, the 1-1,000 in 2 days, the 1-10,000 remained healthy.

June 30, 1913. 1-250, 1-500, 1-750, 1-1,000. Black spots appeared on the leaves of all but the latter in 1 day.

Cedar Oil. July 3, 1912. 1-50, 1-100, 1-500. The base of the stem in all 3 was killed and shrunken in 5 days.

Chromic Acid. August 13, 1913. 1-100, 1-200, 1-500, 1-1,000. All killed in 1 day.

September 24, 1914. 1-1,000, 1-2,000, 1-3,000, 1-4,000. In 4 days all were dead.

Chloral Hydrate. June 25, 1912. 1-200, 1-500, 1-1,000, 1-5,000. The 1-200 showed injury in 5 days; none on the others. Septoria developed on the 1-5,000.

June 30, 1913. 1-150, 1-200, 1-500, 1-1,000. The first two showed injury in 2 days.

Cyanin. August 3, 1912. 1-200, 1-1,000, 1-10,000, 1-50,000. Injury showed on the 1-200 in 1 day, on 1-1,000 in 5 days, 1-10,000 in 6 days.

July 15, 1913. 1-10,000, 1-15,000, 1-20,000, 1-30,000. On the fifth day, all except the weakest solution showed yellow leaves but in 10 days, only the 1-10,000 had died.

Eosin. July 1, 1912. 1-1,000, 1-10,000, 1-100,000, 1-1,000,000. The plants all wilted down in from 1 to 3 days except in the weakest concentration.

Formaldehyde (40%). July 25, 1912. 1-50, 1-100, 1-500, 1-1,000. All wilted in 1 to 2 days.

July 8, 1913. 1-100, 1-500, 1-750, 1-1,000. All showed brown spots in the leaves in 1 to 2 days.

September 5, 1913. 1-750, 1-1,000, 1-1,500, 1-2,000. Plants died in 3 to 6 days.

March 11, 1914. 1-2,000, 1-2,500, 1-3,000, 1-4,000. Injury at the base showed on the 1-2,000 in two days and in 1-2,500 in 3 days. No injury on the others.

Glucose. July 25, 1912. 1-50, 1-100, 1-500, 1-1,000. Injury showed on 1-50 in 2 days and on 1-100 in 4 days, none on the others. Septoria developed only on 1-1,000, none on the control in water.

Hydrogen Peroxide (*Dioxygen*). August 23, 1912. 1-50, 1-100, 1-500, 1-1,000. No injury.

August 1, 1913. The same repeated. No injury. Septoria developed abundantly on all.

March 11, 1914. 1-1, 1-5, 1-10, 1-20. The leaves were slightly yellow on the 1-1 on the third day. The next day, the 1-5 was turning yellow and the 1-1 had yellowed decidedly. No other effect was observed.

Iodine Green. July 2, 1912. 1-500, 1-1,000, 1-10,000, 1-100,000. Next day, the stems in 1-500 were blue; the second day these and those in 1-1,000 were wilted. In 6 days, all were dead.

Iron Sulfate. August 3, 1912. 1-50, 1-100, 1-500, 1-1,000, 1-5,000. The two higher concentrations injured the plants in 1 day; the 1-500 in 5 days.

July 15, 1913. 1-500, 1-600, 1-800, 1-1,000. All the plants showed yellow spots in 5 days, but only the 1-500 died.

December 17, 1913. 1-50, 1-100, 1-200, 1-500. All the plants died in 3 to 6 days, according to the concentration.

December 27, 1913. 1-600, 1-700, 1-800, 1-1,000. In 5 days, the plants on the two higher concentrations were turning brown and in 10 days, these and the next lower were dead. Those on 1-1,000 were slightly yellow in 10 days, but had developed some Septoria and Cladosporium, as had the check in water.

Kerosene. July 3, 1912. 1-50, 1-100, 1-500. The plants in 1-50 and 1-100 wilted in 1 day; in 5 days, all were dead.

Lead Acetate. July 31, 1913. 1-500, 1-1,000, 1-5,000, 1-10,000. In 8 days, the first two were dead. The others remained uninjured and developed Septoria abundantly, as did also the control in water.

Magnesium Sulfate. July 26, 1912. 1-100, 1-500, 1-1,000, 1-5,000. Injury showed on the first in 4 days, at which time Septoria showed on 1-500. No further injury or diseases developed.

July 9, 1913. 1-500, 1-600, 1-700, 1-1,000. No injury or leaf disease developed.

Potassium Ferro-cyanide. June 18, 1912. 1-500, 1-1,000, 1-10,000, 1-100,000. The plants in 1-500 strength died in 1 day. The next showed injury in 4 days. The others developed Cladosporium and Septoria in 6 days, but no further injury showed.

June 26, 1913. 1-700, 1-1,000, 1-5,000, 1-10,000. Injury showed around the edges of the leaves in 1 to 2 days on all but the latter.

Potassium Iodide. May 3, 1912. 1-100, 1-500, 1-1,000, 1-5,000, 1-10,000. In 6 days, the plants in the 2 higher concentrations were dead and the lower leaves had fallen from the others. Septoria and Cladosporium developed on all except those which died.

June 25, 1912. 1-250, 1-500, 1-750, 1-1,000, 1-5,000. Injury showed on the first two in 3 to 5 days.

Potassium Hydroxide. July 1, 1912. 1-100, 1-500, 1-1,000, 1-5,000. The plants wilted and died in 1 to 3 days, according to the concentration.

Potassium Chloride. August 2, 1913. 1-100, 1-500, 1-1,000, 1-5,000. In 3 days, one of the plants on 1-500 was dead. No further effect was noticed.

Potassium Chromate. August 12, 1913. 1-100, 1-200, 1-500, 1-1,000. All dead in 2 days.

September 26, 1913. 1-1,000, 1-2,000, 1-3,000, 1-4,000. All dead in 4 days.

December 27, 1913. 1-5,000, 1-10,000, 1-50,000, 1-100,000. Both plants on 1-5,000 dead in 3 days. Cladosporium developed on those infected with it. A few Septoria spots developed on the 1-50,000, more on the 1-100,000, and also on the check.

Sulfur. July 1, 1912. 1-10, 1-25, 1-50, 1-100. No injury or leaf disease showed.

August 6, 1913. 1-50, 1-100, 1-200, 1-500. Both plants on 1-50 dead in 6 days; no other effect observed.

Sulfuric Acid. July 1, 1912. 1-100, 1-500, 1-1,000. All died in 1 to 2 days.

Sodium Nitro-prusside. August 12, 1912. 1-500, 1-1,000, 1-10,000, 1-50,000. The first two killed in one-half to 1 day. The others not injured and developed Septoria in 5 days, including the water control plant.

July 21, 1913. 1-1,000, 1-1,500, 1-2,000, 1-2,500. The plants on 1-1,000 browned on the edges in 1 day and in 2 days had wilted down. The 1-1,500 plants showed slight injury the first day, but in 2 days wilted down. The others showed slight injury in 3 to 5 days.

Strychnine Sulfate. June 18, 1912. 1-500, 1-1,000, 1-10,000, 1-100,000. The leaves on the 1-500 turned yellow in 1 day and in 4 days all but the youngest leaves were dead and brown. None of the others showed injury. Septoria developed only on the 1-10,000.

June 30, 1913. 1-700, 1-1,000, 1-5,000, 1-10,000. Injury developed on the first two in 2 days.

Thymol. August 23, 1912. 1-200, 1-500, 1-1,000. All injured in 2 days.

Summary.

In most cases where Septoria or Cladosporium growth was secured on the control plants in distilled water and in the lower concentrations of the chemicals tested, the higher concentrations killed or injured the plants before the fungi could develop. In a few instances, there is some indication that concentrations lower than those causing injury may have reduced the development of the leaf parasites more than on the controls. This is shown with potassium nitrate, sodium acetate, morphine sulfate, calcium nitrate, copper sulfate, lime water, sodium tungstate and potassium permanganate. In some cases, the Cladosporium seemed to develop on concentrations higher than the Septoria. This is quite marked in case of acid phosphate.

On mercuric chloride, sodium nitrate, barium nitrate, cerium sulfate and notably on oxalic acid, Septoria developed even on plants showing injury from the chemicals.

The concentrations that tomatoes will stand without injury was determined for about 50 chemicals.

Conclusions.[1]

1. Some previous investigations have shown increased resistance to leaf diseases in various plants after the application of certain chemicals through the stem or to the roots. Others have obtained negative results.

2. In the experiments here recorded, tomato plants to whose roots various chemicals in different strengths were applied, in some cases developed less leaf disease (in the case of *Septoria lycopersici* in particular) on the higher concentrations, where these were not strong enough to cause injury, than on the lower concentrations or in water. In general, the results were negative.

1 A more promising line of attack against *Septoria lycopersici* lies in the natural resistance, which a series of investigations now in progress has shown to be quite varied in the seedlings of different varieties. These vary both in the rapidity of development of the fungus in the leaves and in the number of disease spots produced. The dwarf varieties are especially susceptible to Septoria.

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CONTENTS.

	Page.
Introduction	17
Soil applications	17
Direct injection methods	18
Serums and toxins	18
Effect of fertilizers on corn diseases	19
Internal medication of tomatoes	19
Work on tomatoes at this Experiment Station	20
Summary of chemicals used and results from the same	22
Summary	29
Conclusion	30